EDISON ELECTRIC INSTITUTE

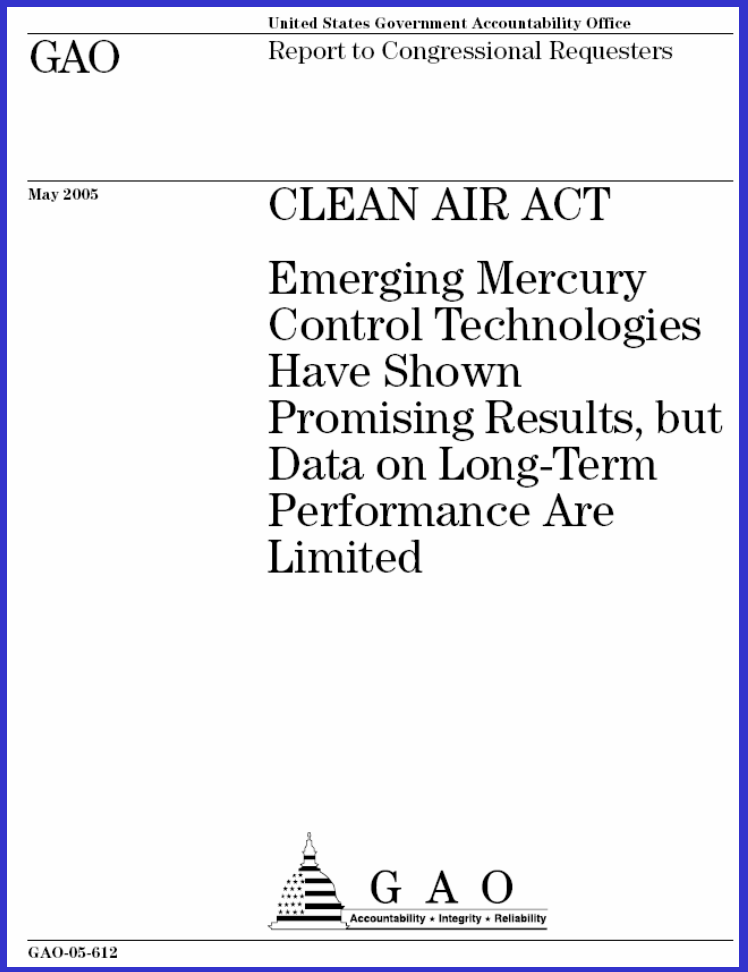
STATUS OF MERCURY CONTROLS: ELECTRIC UTILITY PERSPECTIVE

Michael Rossler
Edison Electric institute
Virginia Mercury Symposium
November 29, 2007

Utility Industry Commitment

- Substantial reductions in emissions already have been achieved
- Substantial reductions will continue
- Industry supports efficient and cost-effective actions to further reduce emissions
- Industry undertaking substantial research on control technologies with DOE, EPA and other federal agencies

GAO Mercury Controls Report



United States Government Accountability Office

GAO

Report to Congressional Requesters

May 2005

CLEAN AIR ACT

Emerging Mercury Control Technologies Have Shown Promising Results, but Data on Long-Term Performance Are Limited

G A O

Accountability • Integrity • Reliability

GAO-05-612

GAO Mercury Controls Report

- Tests of varying duration of… sorbent injection have achieved average Hg reductions of 30-95%, with results depending on the rank of coal burned and other factors
- Data on long-term performance of Hg controls or the effect that they have on the overall reliability and efficiency of power plants are limited… most field tests have lasted less than 3 months
- Perceptions about the availability of Hg controls vary widely among stakeholders… stakeholders do not consistently define "availability"

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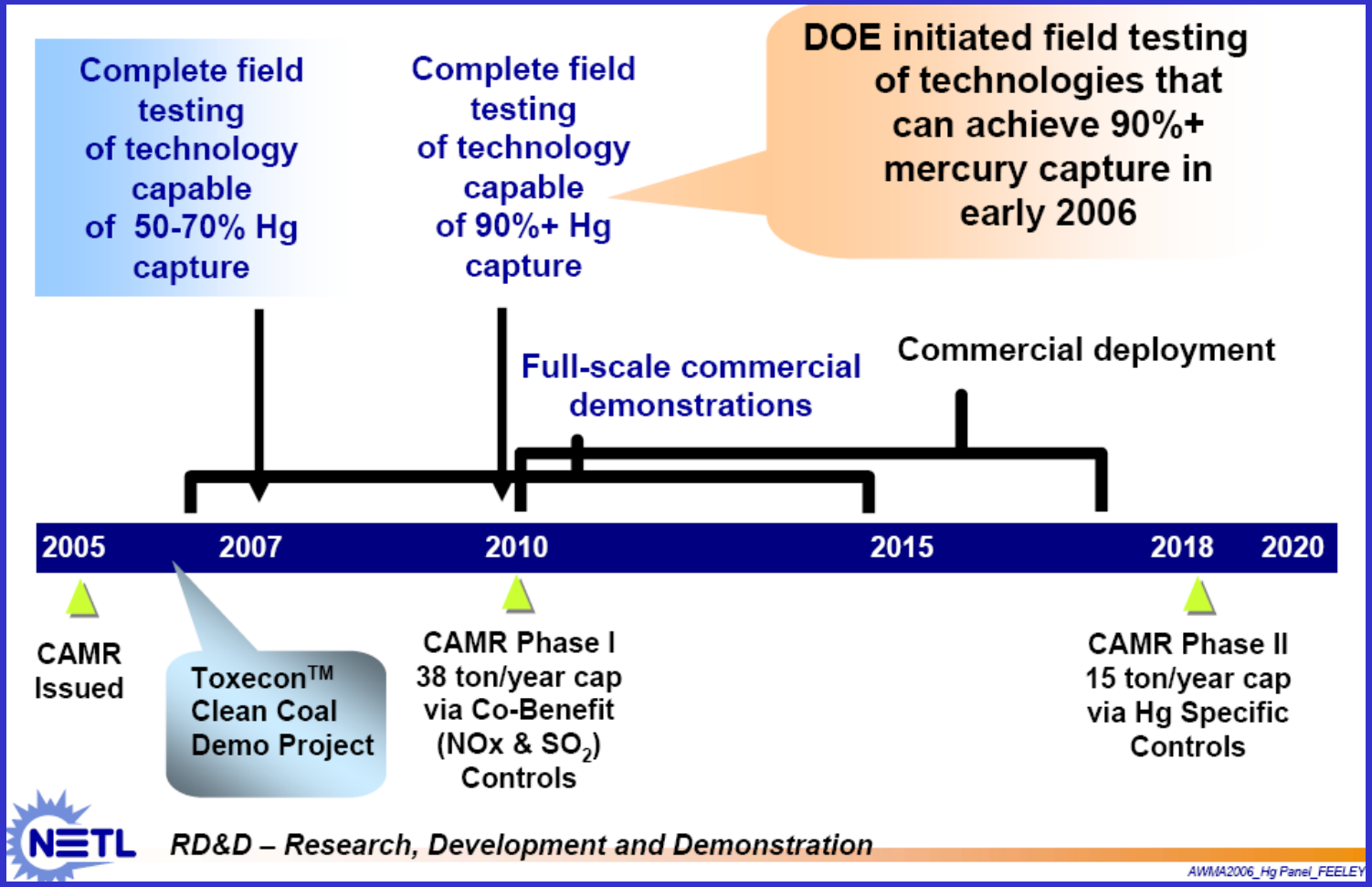
GAO Mercury Controls Report

- The cost to install and operate Hg controls depends on a number of factors, including the extent to which controls already in place to reduce other pollutants also reduce Hg emissions
- Many stakeholders were confident in the ability of plants to achieve a 50% reduction in Hg emissions by 2008; a majority… not at all confident or less confident in the ability of plants to achieve 90% reductions nationwide by 2008

DOE RD&D Timeline



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DOE Mercury Controls Clarification

U.S. Department of Energy

National Energy Technology Laboratory

April 25, 2006

Clarification of the U.S. Department of Energy's Perspective on the Status of Mercury Control Technologies for Coal-Fired Power Plants

DOE Mercury Controls Clarification

- Considerable progress has been made advancing our basic understanding of Hg in coal-fired power plant flue gas and what technologies could be used to control power plant Hg emissions
- A number of critical technical and cost issues remain that need to be resolved through additional research before these technologies can be considered commercially available for all U.S. coals and the different coal-fired power plant configurations in operation in the U.S.
- One size does not fit all in regards to controlling Hg from the broad range of coals burned by, and various pollution control equipment installed on, today's coal-fired power plants

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DOE Mercury Controls Clarification

- Effects of continuous long-term ACI operation on a plant's particulate control device is still under investigation

- Preliminary economic analysis reveals annual O&M costs associated with ACI represent over 80% of total levelized cost
- Future regulatory implications regarding management of coal byproducts due to Hg concerns could increase electricity costs associated with Hg control by a factor of 2-4 compared to Hg control costs without byproduct impacts
- Current field testing program has been limited to testing at 28 coal-fired units, representing ~2.3% of the 1,165 coal-fired generating units in operation in the U.S.

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Mercury Capture Co-Benefits

APCD Configuration	Overall Average Percentage Mercury Capture				
	Bituminous		Subbituminous		Lignite
	w/o SCR	w/ SCR	w/o SCR	w/ SCR	w/o SCR
CS-ESP	28 (0 - 92)	8 (0 – 18)	13 (0 – 61)	69 (58 – 79)	8 (0 – 18)
CS-ESP + Wet FGD	69 (41 – 91)	85 (70 – 97)	29 (2 – 60)	NA	44 (21 – 56)
HS-ESP	15 (0 – 43)	NA	7 (0 – 27)	NA	NA
HS-ESP + Wet FGD	49 (38 – 59)	NA	29 (0 – 49)	NA	NA
FF	90 (84 – 93)	NA	72 (53 – 87)	NA	NA
FF + Wet FGD	98 (97 – 99)	NA	NA	NA	NA
SDA + FF	98 (97 – 99)	95 (89 – 99)	19 (0 – 47)	NA	4 (0 – 8)
SDA + CS-ESP	NA	NA	38 (0 – 63)	NA	NA
PS	NA	NA	9 (5 – 14)	NA	NA
PS + Wet FGD	32 (7 – 58)	91 (88 – 93)	10 (0 – 74)	NA	33 (9 – 51)

CS-ESP = cold-side ESP; HS-ESP = hot-side ESP; PS = particulate scrubber; SDA = spray dryer adsorber

DOE Economic Analysis of ACI

- Field tests still represent relatively short-term testing at optimum conditions
- Limited duration of testing does not allow for comprehensive assessment of several key operational and BOP issues associated with ACI in general and the use of chemically-treated PAC and SEA specifically
  - changes in coal characteristics (e.g., Hg and Cl content)
  - changes in load
  - impacts on small collection area ESPs
  - PAC carryover into downstream APCD
  - corrosion issues
  - potential off-gassing of bromine compounds
  - formation of flue gas halides
  - leaching from brominated PAC byproducts

DOE Economic Analysis of ACI

Table 1 -- 20-Year Levelized Cost of Mercury Control for Bituminous Units

Plant	Byproduct Impacts	50%			70%			80- 90%*		
		ACI, lb/MMacf	COE Increase, mills/kWh	$/lb Hg Removed	ACI, lb/MMacf	COE Increase, mills/kWh	$/lb Hg Removed	ACI, lb/MMacf	COE Increase, mills/kWh	$/lb Hg Removed
Yates Unit 1 (Super HOK)	without	3.85	0.98	$55,200	8.98	1.72	$69,500	N/A		
	with		2.92	$165,000		3.66	$148,000			
Monroe Unit 4 (DARCO® Hg)	without	1.46	0.38	$17,200	3.38	0.75	$24,000	5.78	1.20	$33,800
	with		1.62	$73,100		1.99	$63,900		2.45	$68,800
Lee Unit 1 (B-PAC™)	without	2.07	1.14	$71,400	4.83	1.95	$87,200	8.27	2.95	$103,000
	with		2.85	$179,000		3.66	$164,000		4.67	$163,000
Portland Unit 1 (Mer-Clean™ 8-21)	without	0.59	0.45	$13,400	1.39	0.69	$14,900	5.34	1.94	$32,300
	with		1.60	$47,900		1.84	$39,600		3.09	$51,500

Table 2 -- 20-Year Levelized Cost of Mercury Control for PRB Units

Plant	Byproduct Impacts	50%			70%			90%		
		ACI, lb/MMacf	COE Increase, mills/kWh	$/lb Hg Removed	ACI, lb/MMacf	COE Increase, mills/kWh	$/lb Hg Removed	ACI, lb/MMacf	COE Increase, mills/kWh	$/lb Hg Removed
Holcomb Unit 1 (DARCO® Hg-LH)	without	0.11	0.15	$4,380	0.27	0.18	$3,910	1.03	0.37	$6,090
	with		0.86	$25,600		0.89	$19,000		1.08	$17,900
St. Clair Unit 1 (B-PAC™)	without	0.26	0.39	$17,200	0.60	0.52	$16,300	2.31	1.16	$28,500
	with		1.36	$60,500		1.49	$47,200		2.13	$52,500
Meramec Unit 2 (DARCO® Hg-LH)	without	0.27	0.38	$12,200	0.62	0.48	$11,100	2.40	0.99	$17,800
	with		1.74	$56,100		1.84	$42,400		2.35	$42,100
Dave Johnston Unit 3 (Mer-Clean™ 8)	without	0.06	0.26	$7,440	0.14	0.30	$5,970	0.55	0.46	$7,190
	with		1.55	$44,000		1.59	$32,100		1.75	$27,500
Stanton Unit 1 (B-PAC™)	without	0.41	0.39	$16,700	0.95	0.54	$16,500	3.65	1.29	$30,500
	with		1.07	$45,400		1.22	$36,900		1.97	$46,400

Table 3 - 20-Year Levelized Cost of Mercury Control for ND Lignite Units

Plant	Byproduct Impacts	50%			70%			80- 90%†		
		ACI, lb/MMacf	COE Increase, mills/kWh	$/lb Hg Removed	ACI, lb/MMacf	COE Increase, mills/kWh	$/lb Hg Removed	ACI, lb/MMacf	COE Increase, mills/kWh	$/lb Hg Removed
Leland Olds Unit 1 (DARCO® Hg & $CaCl_2$)	without	2.15	0.74	$18,300	5.04	1.21	$21,500	8.65	1.81	$24,900
	with		3.37	$83,600		3.84	$68,200		4.44	$61,200
Stanton Unit 10 (DARCO® Hg-LH)	without	0.49	0.85	$20,300	1.15	1.05	$17,900	1.98	1.30	$17,300
	with		2.58	$61,500		2.78	$47,300		3.03	$40,100
Leland Olds Unit 1 (Mer-Clean™ 8)	without	0.18	0.32	$7,900	0.42	0.42	$7,400	1.64	0.91	$12,600
	with		2.95	$73,200		3.05	$54,100		3.54	$48,900

* Table 1 displays economic data for 80% ACI mercury removal at Monroe and Lee, and 90% ACI mercury removal at Portland.
† Table 3 displays economic data for 80% ACI mercury removal at Leland Olds and Stanton 10, and 90% ACI mercury removal via Mer-Clean™ 8 injection at Leland Olds.

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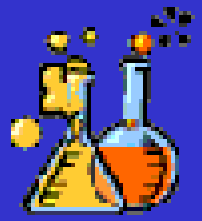
UPDATED Economic Analysis of Activated Carbon Injection , May 2007

Status of Mercury Controls (EERC)

- Only at the demonstration phase
- Limited short-term (30 days) testing at full-scale and over wide range of plant configurations
- No one-size-fits-all technology due to coal properties and boiler configuration
- Need longer-term (>1 year) successive demonstrations with adequate time to learn and improve technologies
- Guarantees do not cover all concerns (*i.e.*, AC feed rate)

BOP Impacts Remain Undefined

- Sustainable Hg control under variable plant operating conditions
- Corrosion from boiler additives or enhanced (chemically-treated) carbons
- Potential emissions of additives or impregnation chemicals or release from ash
- ESP collection efficiency
- Bag life in FF's resulting from increased cleaning cycles and/or pressure drop increase (appears after 6 months)
- Ash utilization in concrete; potential organo- and elemental Hg releases from ash used as structural fill or soil amendments



A State's View: West Virginia

- Evaluation of Control Technologies for Mercury Air Emissions (October, 2006)
  - Hg combustion chemistry in coal-fired electric-utility boilers is still not well understood, which may lead to unintended results—which both EPA and EPRI staff call "surprises"—when different air-pollution-control technologies, including combinations of such technologies, are examined at power plants.
  - "One size does not fit all" regarding controlling Hg from the broad range of coals burned by, and various pollution control equipment installed on, today's coal-fired power plants.
  - To better serve both the public and the regulated community, and to assist state and federal agencies in establishing rules and guidance to control mercury air emissions from coal-fired power plants and other industrial stationary sources of mercury, industry, regulatory agencies and the regulated community promptly should develop an acceptable definition of "commercially available" or "commercial availability."

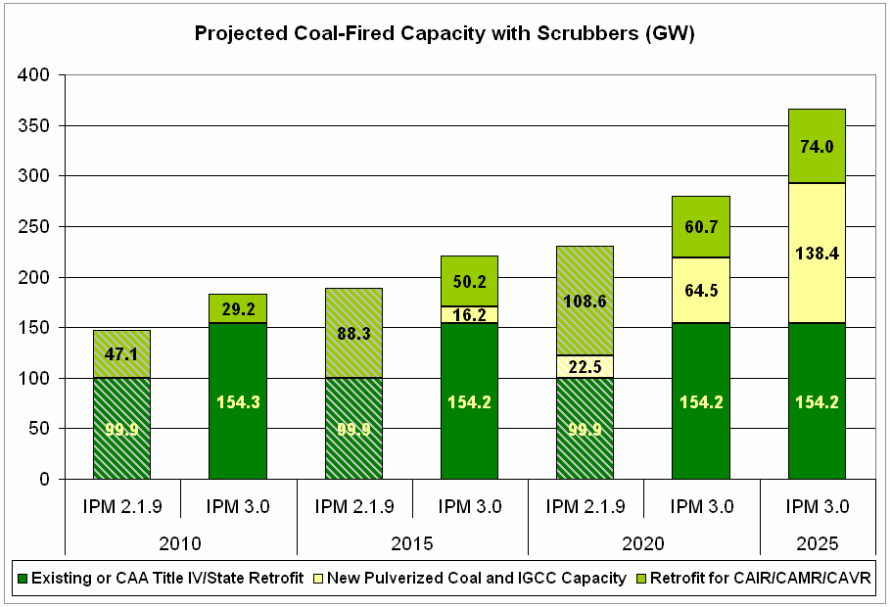
Vendor “Guarantees”

- Limited experience with Hg control guarantees
  - Very different supplier responses
- All “Fix or make right”
- Maximum value limited per contract (for ACI, $1-2 M or less)
- No collateral, consequential damages
- Bottom line: Companies are on their own

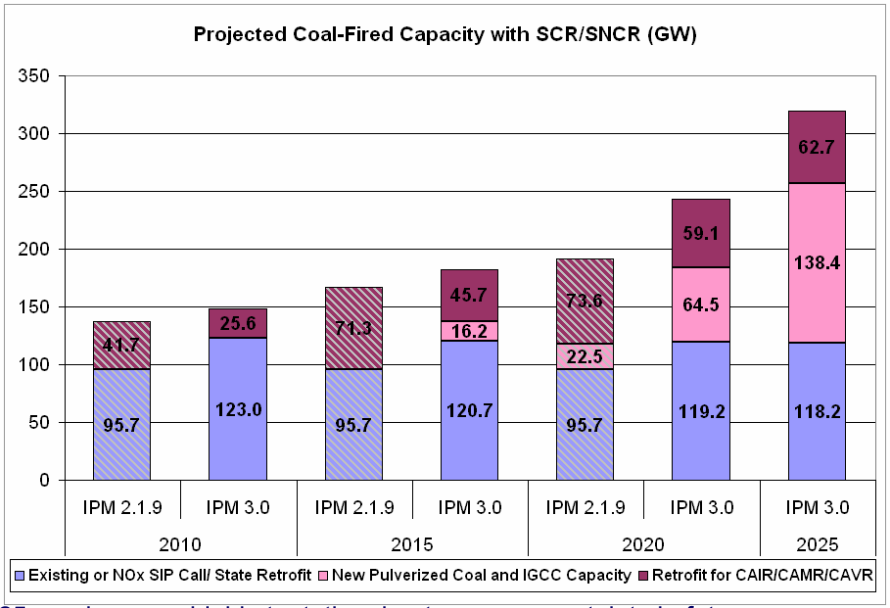
Increasing Demand = Increasing Costs

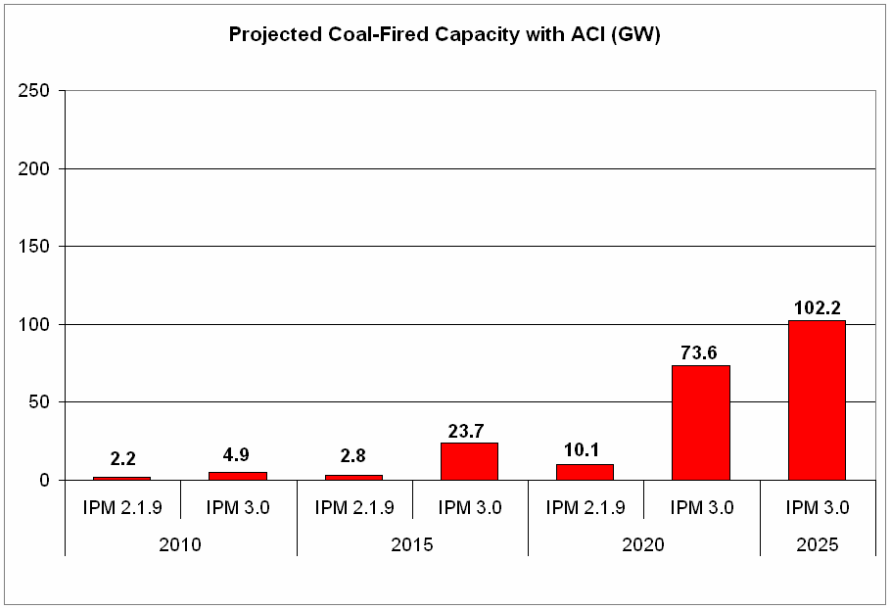
- Unprecedented demand for FGD, SCR, new PC Plants
  - Extended schedule
  - Higher capital cost
- No relief in sight (2015?)
- Few options only:
  - Consolidate design/procurement with others
  - Reference design
  - Non-traditional suppliers

Advanced Pollution Controls



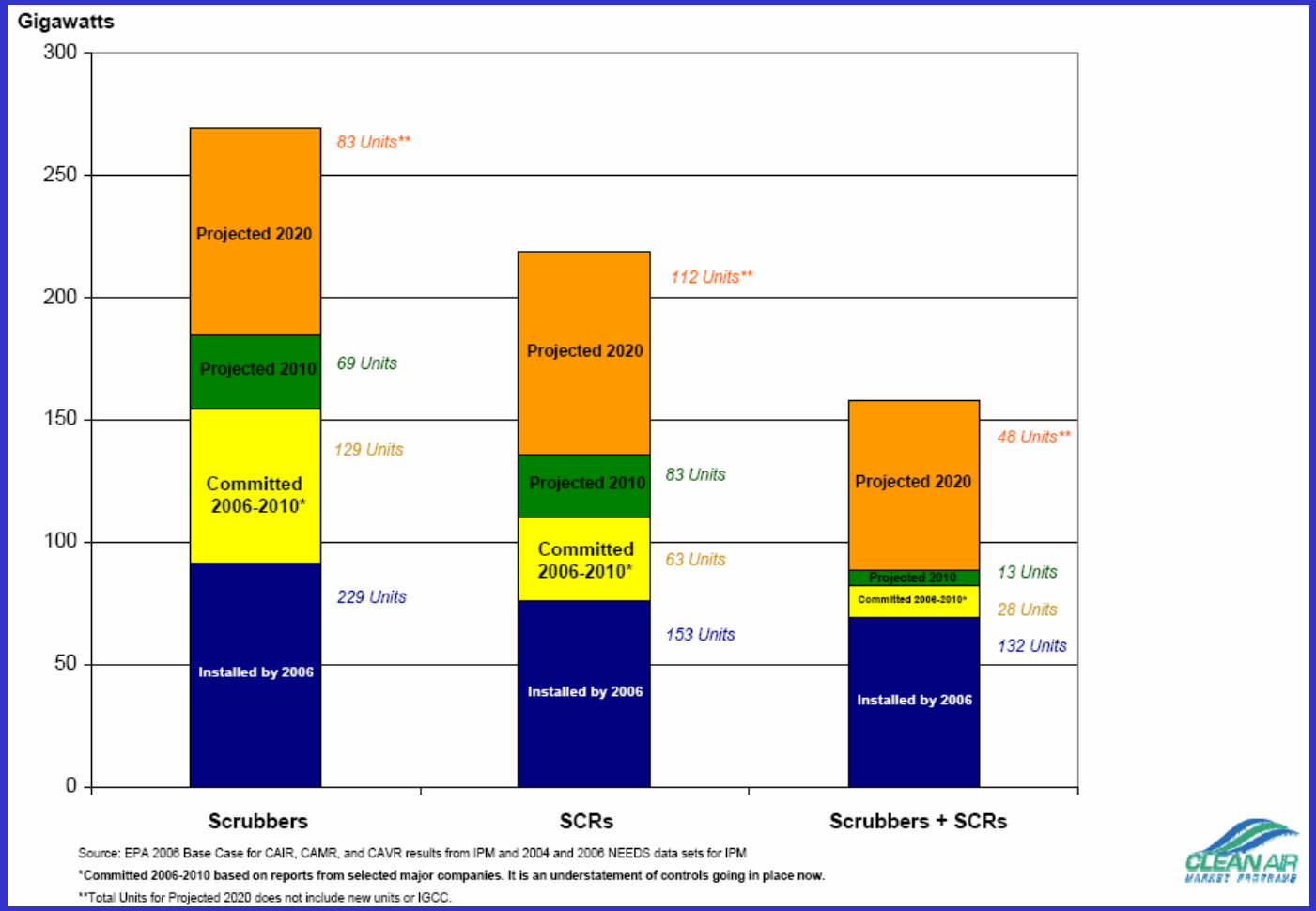
- Increased coal generation under environmental constraints, including new State regulations and NSR settlements, leads to more advanced SO_2, NO_x, and mercury controls in IPM 3.0 installed earlier.
- Rise in subbituminous coal consumption leads to more ACI retrofits (and an increase in mercury allowance prices).





*2025 numbers are highly tentative due to more uncertainty in future years.

Installed, Committed, Projected SO_2 & NO_x Controls



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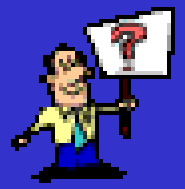
Mercury CEMS Issues

- Reliability, operability and complexity
- Availability of calibration standards that are NIST traceable: Hg^0 and especially Hg^{2+}
- No Hg CEMS can be certified until equipped with a NIST traceable calibrator
- All Hg CEMS must be certified during 2008
  - CAMD requiring use of ECMPS Client Tool
- Ready by January 1, 2009 ??



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Summary

- Progress has been made, and will continue with substantial utility industry involvement
- Long-term testing needed; reliability of controls and many BOP effects still unknown
- Not all existing boiler types, configurations, and coal types have been tested/assessed
- Several control options needed: “one size does not fit all” of the diverse boiler fleet

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Summary

- Cannot consider controlling mercury in isolation; utilities are continuously preparing to comply with multiple state and federal requirements for multiple pollutants
- Mercury controls are still in a demonstration phase; no proven, widely available technology exists… yet
- Costs of control are significant due to global demand and increasing material costs
- Monitoring component: costs, reliability, availability

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